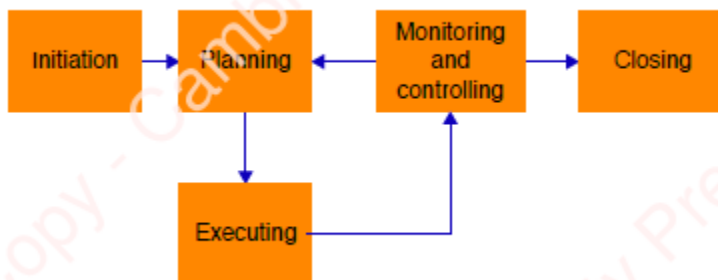


15 Project Management

- Project management is about applying a process to enable the completion of a project on time and within budget
- It can be broken down into initiation, planning, execution and monitoring and close stages.
- Project management software can be used to assist a project team throughout a project and tools such as Gantt charts, PERT and CPM can be used to aid project planning.
- Failure to complete projects on time and within budget can be embarrassing for organizations who have made promises on delivery and frustrating for the end user

15.1 The stages of the project life cycle



Project Initiation

- During the project conception and initiation stage, the initial ideas for a project are identified and goals are set.
- Key stakeholders are identified and decisions are made about whether or not it's appropriate to undertake a project by creating a feasibility study, which will determine whether the project is of benefit to an organizations based on resources, time and finance
- Requirement for project are identified so all stakeholders are aware of the expectations of the project
- Objectives of the project its scope, risks, approximate budget and approximate timescales will be defined and agreed with all stakeholders

- An estimate of required resources will be made and a high level schedule will be created that identifies proposed dates for completion and aspects of the project
- A project brief or project initiation document (PID) or initial statement of work (SoW) is created.
- At the end a phase review will take place to check if all aspects have been completed and all stakeholders understand and agree the project brief

Project Planning

- A comprehensive budget will be formulated along with details of timescales for the progress of the project
- Milestones will be set, that show by which time certain aspects of the project must be completed
- Tasks will be identified and prioritized that have to be completed between each milestone
- A Gantt chart will be produced to show which tasks need to be completed and in which order
- Resources including personnel will be allocated to tasks in coordinated manner so they are available at right times, this is to prevent them from being not used or overused
- At the end, a phase review will be carried out to check if the plan is achievable and it meets the objectives of the project

Project Execution

- It is critical that the plan is followed so that resources are used at the appropriate times.
- Any delays to a task can have a knock-on effect to successor tasks.
- The project manager will be expected to communicate roles and responsibilities to team members and set interim targets for each member to achieve within the timescales of the overall plan.
- At the end of the project execution phase, an execution phase review will take place to learn lessons from what went wrong and to note examples of good practice. The review will cover questions such as:
 - Was the project schedule maintained?
 - Was the project within budget?
 - Were all resources available when required?
 - Has the project met the original requirements?

Project Monitoring and Control

- Throughout the execution of the project, the project manager must monitor the progress and control what is happening as they will be responsible for ensuring tasks are completed on time and for rescheduling any tasks in case of delays
- Project manager will need to monitor the performance of team members to ensure they are carrying out their agreed roles effectively
- They will need to monitor expenditure and compare it against the budget to ensure no overspend occurs and keep a close eye on the scope of the project to ensure it doesn't extend beyond the agreed boundaries.
- Objects will be regularly reviewed to ensure the project is meeting its original objectives
- There should be regular project review meetings where key stakeholders can discuss the progress of the project
- At times, the project plan will need to be adjusted, so there is regular iteration between the execution, monitoring and control, and planning phases as shown

Project Close

- At times, the project plan will need to be adjusted, so there is regular iteration between the execution, monitoring and control, and planning phases as shown
- Contracts will be terminated, which means some people may need to be deployed elsewhere or may need to look for alternative employment
- Resources that have been assigned to the project will be released
- A review of the project will take place between the client and the project management team, where requirements will be evaluated and successes will be celebrated
- The client will be expected to sign off the project as completed, so that it is clear there is no further work to carry out and closure will have been achieved.

15.2 Project management software

Planning

- Most of the planning involved using project management software is concerned with scheduling tasks and allocating resources to those tasks.
- However key milestones can be identified in advance, these are when crucial points in the project should be reached, so tasks should be scheduled to meet these milestones

- Documents that are likely to be required can be allocated to milestones, such as success criteria and specifications.
- Templates can be used for setting up an initial project plan, these templates can be provided by the software or they could be templates that are created based upon an organisation's previously successful projects.
- Through the use of project templates, company standards can be set up for the way projects should be planned, so employees have a common, collaborative and recognisable structure.

Scheduling of Tasks

- Tasks are jobs that need to be completed as part of the project.
- Project management software will enable a project manager to create a Gantt chart to show an overview of the tasks that need completing on a timeline.
- Tasks will be assigned an estimated number of hours or days that they will take to complete, together with a deadline for completion.
- The project manager will be able to identify which tasks are dependent upon other tasks and so cannot start until those other tasks have been completed.
- Tasks can be delegated to other members of the team and put in a priority order to identify which should be completed first.
- Team members will be able to record how many hours have been spent on each task and identify when the task is complete.
- Milestones can be identified for crucial points of the project and these can be highlighted.
- A milestone is often a point at which a key part of the project has been completed or part of the project has been delivered (known as deliverables).
- The project manager will be able to see an overall calendar of all tasks that need to be completed, together with calendars for each team member that is responsible for tasks.

Allocation of Resources

- Resources can be equipment, property or people that are required to complete a task.
- These resources will need to be defined within the project management software and their availability can be identified so the project manager knows when they can be used.
- Costs can be assigned to any resource, so the project manager can see how their use will affect the budget.
- Resources can then be assigned to tasks and a number of hours or days be assigned to the use of that resource.
- The software will help the project manager to avoid resource conflicts and also identify clearly situations where team members could experience overload, this is when a team member has too many tasks to complete during a period of time.

Costings

- All resources will have costs allocated to them, so the project manager will be able to calculate the total cost of each task based on how many hours each resource is used for each task.
- The software can be used to keep a record of any expenses incurred by team members and account for these in the overall costs.
- Daily, weekly, monthly or custom analysis of expenditure and its comparison to the budget can be provided.
- The software can report on the total costs for each individual resource or set of resources.
- The costings information will be able to be exported to common formats such as spreadsheets for further manipulation and analysis.

Communication and Collaborative Working

Project management software can offer a large variety of communication tools which help team members to **collaborate** throughout the whole project:

- **Calendars:** each team member will have a calendar showing what they are doing at any time. These can be synchronized with third-party calendars, such as Google, iCal or Outlook, so that each member's availability is always up to date. This enables meetings to be scheduled with each team member. Documents can be attached to these meetings so that they are readily available to each participant.
- **Instant messaging/video chat/video conferencing:** these tools enable team members who are working remotely from each other to communicate real time so that they can share ideas and discuss progress.
- **Shared documents:** all documents should be stored in a central repository so that they are available to the team members who require access to them. Documents can be assigned to tasks, resources or milestones so that they are available at the right time to the right people. Changes to the documents can be tracked so that each team member knows what modifications have been made and which is the latest version of the document. The software can email team members to inform them when changes to documents have been made or display an alert on their project dashboard, their home page for the project management software. This is a much more controlled manner of dealing with documents than email attachments and mixed revisions.
- **Discussions/forums:** these can be set up for tasks, documents or milestones so that discussions between team members can be held. This is particularly useful when all

team members are not available at the same time. Team members will be able to see comments and suggestions that have been made by others and respond to them. Email notifications of new contributions to discussions can be sent or alerts can be displayed on project dashboards.

- **Progress:** the software can inform team members and the project manager of progress that is being made. Team members can update tasks to show how near to completion they are and this progress can be fed into the whole project plan. If changes are made to the project timeline, automated email notifications can be sent out to all affected team members.

Decision Making

- All communications within the project management software can be logged and tracked so that if decisions have been made, then it is possible to clearly identify who made each decision and for what reasons.
- If problems or issues have been experienced, then these will be highlighted by the software and decisions can be made as to what adjust need to be made such as changing the timeline or allocating additional resources
- Graphs, charts and reports can be used to analyze the budget, scheduling and task progress.
- Comparisons can be made between the plan and what is happening during the execution of the project, and then decisions can be made to make changes if necessary.
- The software will identify a **critical path** which will show all tasks that must complete on time if the project is to meet its deadline
- The software will show an overview of the availability of resources and the time allocated to each and their respective costs, so that the project manager is able to relocate them as necessary

Weaknesses of Project Management Software for Supporting Projects

- Good quality project management software is a large financial investment, especially if it needs to be used by several users.
- Project managers need extensive training to use the software effectively and team members also need training to use the components that are relevant to their tasks.
- The complexity of the software can also over complicate simple projects which could have been managed more effectively without the software.
- Users can become too reliant on the software to remind them that tasks need to be completed.
- Online project management software will enable access for many users which is good for collaboration, but it creates a risk that unauthorized users may access sensitive data that they shouldn't have access to.

15.3 Tools and techniques for project management tasks

Gantt Charts

- A Gantt chart is used to show the start and finish dates of each task, the predecessors for each task, the progress of each task and the current position within the project.
- Tasks are listed with their start and finish dates.
- A bar represents each task. Each bar can be shaded in to show the percentage of the task that has been completed.
- Arrows are used to show which tasks are dependent upon other tasks.
- A line or other indicator can be used to show the current position (time) within the project.
- It's also possible to identify the resources required, usually by listing the person responsible for each task.

To create a Gantt Chart, you need to know the following:

- the list of tasks
- how long each task will take
- which tasks are dependent upon predecessors
- start date of the first task
- resources that are allocated to each task.

WORKED EXAMPLE 15.06

Task A starts on 1 January 2020.

Task	Days	Dependencies	Resources
A	3		R1
B	2	A	R1
C	6	A	R2
D	1	B	R1
E	3	C	R2
F	5	D	R3
G	4	E, F	R3
H	3	G	R5
I	2	G	R2
J	3	G	R6

First, create a list of tasks, the duration and the resources required and identify the start and finish dates of the first task.

JAN					
Task	Duration	Start	End	Resources	
A	3	1-1-20	3-1-20	R1	
B	2			R1	
C	6			R2	
D	1			R1	
E	3			R2	
F	5			R3	
G	4			R3	
H	3			R5	
I	2			R2	
J	3			R6	

Figure 15.11: Gantt chart part 1.

Then add on any tasks that are dependent on task A, to start the day after task A finishes.

JAN					
Task	Duration	Start	End	Resources	
A	3	1-1-20	3-1-20	R1	
B	2	4-1-20	5-1-20	R1	
C	6	4-1-20	9-1-20	R2	
D	1			R1	
E	3			R2	
F	5			R3	
G	4			R3	
H	3			R5	
I	2			R2	
J	3			R6	

Figure 15.12: Gantt chart part 2.

Continue task by task until there is a completed Gantt chart.

JAN					
Task	Duration	Start	End	Resources	
A	3	1-1-20	3-1-20	R1	
B	2	4-1-20	5-1-20	R1	
C	6	4-1-20	9-1-20	R2	
D	1	6-1-20	6-1-20	R1	
E	3	10-1-20	12-1-20	R2	
F	5	7-1-20	11-1-20	R3	
G	4	13-1-20	20-1-20	R3	
H	3	17-1-20	19-1-20	R5	
I	2	17-1-20	18-1-20	R2	
J	3	17-1-20	19-1-20	R6	

Figure 15.13: Gantt chart part 3.

WORKED EXAMPLE 15.05

Figure 15.8 shows a Gantt chart for developing a book.

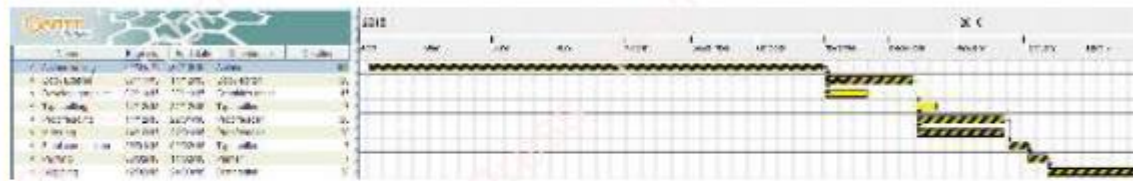


Figure 15.8: Gantt chart.

On the left-hand side you can see the task list together with beginning dates and times, coordinators and the duration. The yellow bars represent the time that each task takes. This makes it much easier to see the float time that is available. Dependencies are shown by the arrows from the end of a predecessor to the start of another task. The black lines represent how much of each task has currently been completed and the red line represents the current time. Therefore, assuming that the progress is correct, the project is running slightly behind schedule. The diagonal lines on the yellow bars represent the critical path.

Critical Path Method (CPM)

- The critical path method (CPM) also known as critical path analysis (CPA), finds project's critical path which identifies which task must complete on time in order for the whole project to complete on time and it defines the minimum time in which the project can be completed.
- It is appropriate for projects where the time needed for each task is known, usually because they are common recurring tasks, for example construction tasks.

WORKED EXAMPLE 15.02

Figure 15.2 shows a network activity diagram for making a cup of tea.

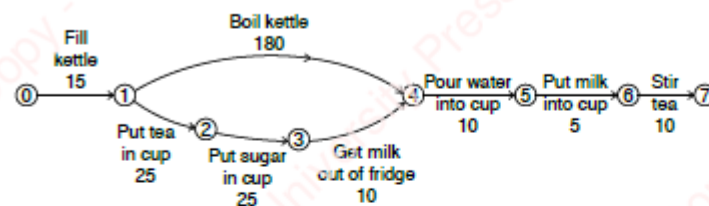


Figure 15.2: Network activity diagram for making a cup of tea.

The circles represent milestones in the project and are numbered for identification purposes. The tasks are represented by arrows. The numbers next to each task represent the number of seconds the task will take. For example, pouring water into the cup will take 10 seconds.

Some tasks can be completed in parallel to other tasks. For example, boiling the kettle can take place at the same time as putting tea in the cup, putting sugar in the cup and getting milk out of the fridge. Where there are parallel tasks, the longest timeline forms the critical path. In this case, 180 seconds to boil the kettle is longer than the 60 seconds it takes to do the three parallel tasks.

Sequential tasks cannot be carried out at the same time because they are dependent upon other tasks completing first. For example, boiling the kettle is dependent upon the kettle being filled with water and so cannot start until the kettle is filled with water. In this case, the kettle being filled with water is a **predecessor** to boiling the kettle.

The total length of the critical path is calculated by adding up all the sequential tasks plus the longest of each of the parallel sets of tasks. In this case that is $15 + 180 + 10 + 5 + 10 = 220$ seconds, which is the shortest time it will take to complete the project. If any of the tasks on the critical path takes longer than planned, then the whole project will be delayed.

- Some tasks aren't critical and have what is known as float time, which is the time an activity can be delayed without affecting the rest of project.
- In the example network activity diagram for making a cup of tea, getting the milk out of the fridge has a float time of 120 seconds because it can be delayed this long before it would catch up with milestone 4.

To create a network activity diagram you need to know the following information:

- The list of tasks
- How long each task will take
- Which tasks are dependent upon predecessors

This information can be shown in an activity dependence table.

WORKED EXAMPLE 15.03

Task	Days	Dependencies
A	3	
B	2	A
C	6	A
D	1	B
E	3	C
F	5	D
G	4	E, F
H	3	G
I	2	G
J	3	G

First, add any tasks to the diagram that have no predecessors.



Figure 15.4: Network activity diagram part 1.

Then add on any tasks that are dependent on task A.



Figure 15.5: Network activity diagram part 2.

Continue task by task until there is a completed diagram.

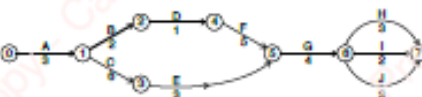


Figure 15.6: Network activity diagram part 3.

Network activity diagrams can be extended to include the earliest start time (ES) and earliest finish time (EF) of a task. The ES of the first task is 0 and the EF of the first task is the length of that task. The ES of all other tasks is the latest EF of its predecessors.

- ES of task = latest EF of predecessors
- The EF of any task is calculated as:
- $EF = ES + \text{length of task}$

The float time can also be added to each task. The float time is calculated by subtracting the EF of a task from the ES of the next task:

- $\text{Float time} = EF \text{ of task} - ES \text{ of next task}$

WORKED EXAMPLE 15.04

Figure 15.3 has been extended to Figure 15.7 below to show the ES in green, the EF in red and float time in blue.

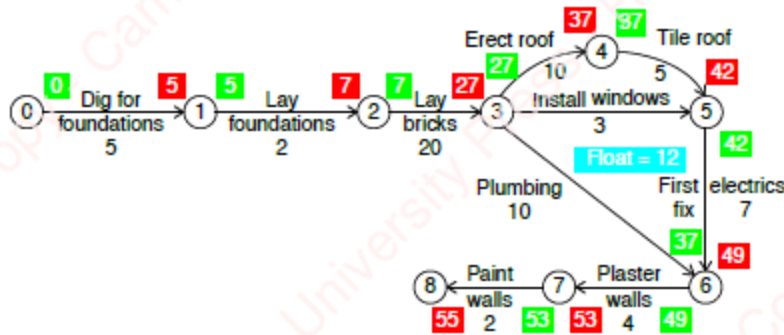


Figure 15.7: Extended network activity diagram.

The ES for dig for foundations is day 0 because it is the first task. The EF for dig for foundations is day 5 because the task will take 5 days. This means that the ES of the next task (lay foundations) is also day 5 because it can only start when the foundations have been dug.

EF for lay foundations = ES for lay foundations + length of lay foundations

EF for lay foundations = $5 + 2 = 7$

When it comes to parallel tasks, the ES of a task is the latest EF of its predecessors. The EF for installing windows is day 30, but the EF for tiling the roof is day 42. As these are both predecessors for first fix electrics, the ES for first fix electrics must be day 42.

The ES for first fix electrics is day 42 but the EF for installing the windows is day 30 meaning there are 12 days of float time.

NOTE: when working in days, the EF and ES are considered to be the beginning of the day. For example, the EF of task 2 is day 4 then task 2 should be finished by day 4 or the end of day 3. This will then enable task three to start at the beginning of day 4.

- Using a network activity diagram can help to allocate the right number of resources to a task.
- For example when a task needs to be completed earlier than planned, additional resources can be allocated to the task, this is known as 'crashing'
- Those additional resources come from tasks with high float time because it's not critical that those tasks finish at their planned earliest finish time.
- When there aren't any float tasks available or the necessary resources can't be found which incur additional costs
- For example in the figure 15.7, if laying of bricks needs to be completed 5 days earlier then there aren't any float tasks available from which to use resources. However if erecting the roof needed to be completed earlier than planned, then resources could be used from the plumbing task which has a float of 12 days.

Performance Evaluation and Review Technique (PERT)

- PERT is similar to CPM in that it is used to plan, schedule and manage projects and activities are based on predecessors.
- It is more suitable for research and development projects which are non-repetitive because estimates of time are used rather than definitive times
- Tasks or activities are represented by arrows and milestones are represented by nodes, usually a circle
- PERT and network activity diagram there look very similar
- **Key difference between them is that time for PERT for each task is estimated**
- To estimate the time, the following are used:
 1. **most optimistic time**
 2. **most likely time** (based on the assumption everything will go right and there will be no problems)
 3. **most pessimistic time** (based on the assumption that anything that can go wrong will go wrong)
- The estimated time is then calculated as:

The estimated time is then calculated as:

$$\text{estimated time} = \frac{4 \times \text{most likely time} + \text{optimistic time} + \text{pessimistic time}}{6}$$

WORKED EXAMPLE 30.02

Reading a PERT chart

A software developer is to produce software for a customer. The activities, deliverables and milestones in Table 30.03 have been identified.

Activity	Description	Weeks to complete	Deliverables	Milestone
			Start	1
A	Identify requirements	1	Requirement specification	2
B	Produce design	2	Program design	3
C	Write program code	8	Complete program code	4
D	Test modules	5	Tested program modules	5
E	Integration testing	2	Tested integrated software	6
F	Install software	1	Software ready to use	7
G	Acceptance testing	2	Software signed off	8
H	Write documentation	4	Technical documentation	9
J	Write training material	2	User documentation	8
K	Train users	3	Users trained	10
L	Go live	1	Finish	11

Table 30.03 Breakdown of project into activities, deliverables and milestones

Reading a Gantt chart

Activity

Identify requirements																				
Produce design																				
Write program code																				
Test modules																				
Integration testing																				
Install software																				
Acceptance testing																				
Write documentation																				
Write training material																				
Train users																				
Go live																				
Week Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

```

graph LR
    1((1)) -- "1  
A" --> 2((2))
    2 -- "2  
B" --> 3((3))
    3 -- "8  
C" --> 5((5))
    3 -.-> 4((4))
    4 -- "5  
D" --> 6((6))
    5 -- "2  
E" --> 6((6))
    5 -- "4  
H" --> 9((9))
    6 -- "1  
F" --> 7((7))
    7 -- "2  
J" --> 8((8))
    7 -- "2  
G" --> 8((8))
    8 -- "3  
K" --> 10((10))
    9 -.-> 10((10))
    10 -- "1  
L" --> 11((11))
  
```

Figure 30.01 demonstrates the following features:

- Milestones are shown as numbered nodes.
- Activities are represented by arrows linking the milestones. The arrows are labelled with the activity code below the arrow and the duration above the arrow.
- Nodes 1, 2, 3, 5, 6, 7, 8, 10 and 11 are joined by solid arrows. These activities must be completed in sequence; they are called 'dependent activities'.
- Activities that must be completed in sequence but that don't require resources or completion time are represented by dotted lines and are called 'dummy activities'. The dotted line between milestones 3 and 4 indicates that the program modules must be tested before software installation can begin, but the time required to do the testing is on another path (path D).

Work Breakdown Structure (WBS)

- A hierarchal decomposition of the project can be created as WBS to help manage tasks
- It's also made to breakdown the scope of the project to show to stakeholder/project participants/developers for ease of understanding
- A WBS forms a hierarchal diagram with tasks allocated to sub tasks or project phases
- It describes in detail all the work required in all the stages of a project so that everyone knows what is/has to be done
- It describes the planned outcomes of the project so that they can be test in later stages
- Each layer describes all of layers below it so that is known what has to be done to reach the stage.

Describe the characteristics of a well-designed WBS [4]

- Content/description could be easily understood by all participants
- Content/work can be managed/divided into manageable units
 - Content/work units independent/separate from each other
 - So work/responsibility can be assigned to individuals
 - So can be clearly assigned to individuals
- Duration of work can be estimated giving time for completion/allowing costs to be determined
- Content/work is measurable allowing start/end dates/times to be calculated
- Content/work units can integrated/collected together with other units to create whole project
- WBS is adaptable to cope with amendments/alterations/changes to project scope

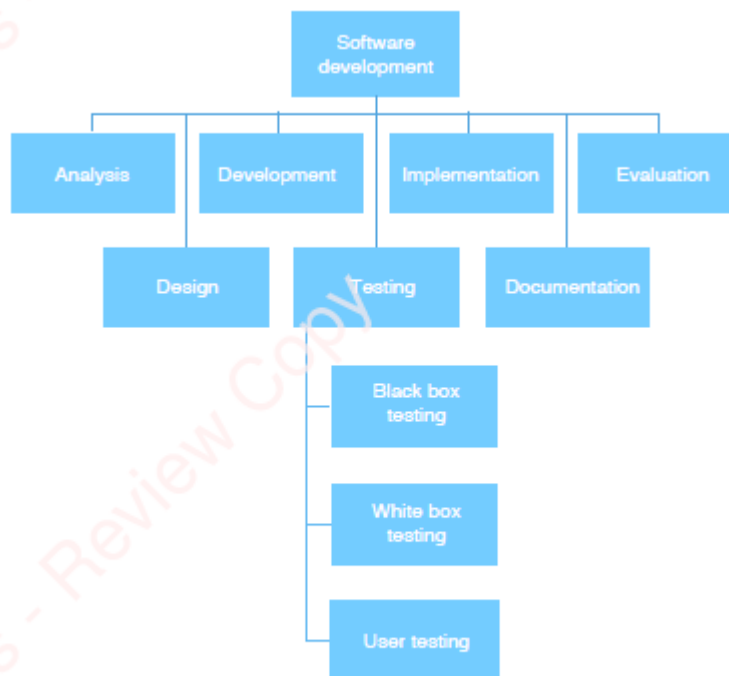


Figure 15.15: WBS for software development with testing expanded.

Describe these project management terms:

- **timings:** Timings in project management refer to the specific durations or timeframes assigned to tasks or activities within a project schedule. It can help in planning and coordinating project activities, ensuring that tasks are completed within specified time limits. It allows project managers to create realistic schedules and manage resources efficiently.
- **float:** Float also known as slack is the amount of time by which an activity or task within a project can be delayed without affecting the projects overall completion date. Helps provides flexibility in managing project schedules. Tasks with float can be delayed without causing delays to subsequent tasks or the overall project timeline. It helps in optimizing resources and managing uncertainties
- **end points:** They refer to the conclusion or completion points of activities, tasks or phases within a project. It helps in tracking and assessing the completion of specific components, contributing to overall project success.
- **milestones:** They are significant points or events within a project that represent key achievements, completion of major phases or the meeting of crucial deadlines. They server as markers to track progress, celebrate achievements and align the teams effort. They provide a sense of accomplishment and help in communicating project progress to stakeholders

